FORM PTO-1390 (Modified) (REV 11-98) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER	
HALL-00108	
U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR	09/889370

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/GB00/00108	18 JANUARY 2000	21 JANUARY 1999

TITLE OF INVENTION
POWER SUPPLY FOR PROCESSING OF GASEOUS MEDIA

APPLICANT(S) FOR DO/EO/US
HALL, Stephen, Ivor; INMAN, Michael; MARTIN, Anthony, Robert; RAYBONE, David; WEEKS, David, Michael; SEGAL, David, Leslie

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371 (c) (2))
   a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☒ has been transmitted by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☐ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☐ A copy of the International Search Report (PCT/ISA/210).
8. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))
   a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ have been transmitted by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☐ have not been made and will not be made.
9. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
10. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
11. ☐ A copy of the International Preliminary Examination Report (PCT/IPEA/409).
12. ☐ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).

Items 13 to 20 below concern document(s) or information included:

13. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
14. ☒ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
15. ☒ A **FIRST** preliminary amendment.
16. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
17. ☐ A substitute specification.
18. ☐ A change of power of attorney and/or address letter.
19. ☐ Certificate of Mailing by Express Mail .
20. ☐ Other items or information:

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR) 09/889370	INTERNATIONAL APPLICATION NO. PCT/GB00/00108	ATTORNEY'S DOCKET NUMBER HALL-00108

21. The following fees are submitted:		CALCULATIONS PTO USE ONLY	
BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :			
☐ Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2) paid to USPTO and International Search Report not prepared by the EPO or JPO	**$1,000.00**		
☒ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but Internation Search Report prepared by the EPO or JPO	**$860.00**		
☐ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO	**$710.00**		
☐ International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4)	**$690.00**		
☐ International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4)	**$100.00**		
ENTER APPROPRIATE BASIC FEE AMOUNT =		**$860.00**	
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (e)).		**$0.00**	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	16 - 20 =	0	x $18.00	**$0.00**	
Independent claims	1 - 3 =	0	x $80.00	**$0.00**	
Multiple Dependent Claims **(check if applicable)**.			☐	**$0.00**	
TOTAL OF ABOVE CALCULATIONS =				**$860.00**	
Reduction of 1/2 for filing by small entity, if applicable. Verified Small Entity Statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28) **(check if applicable).**			☐	**$0.00**	
SUBTOTAL =				**$860.00**	
Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (f)).			+	**$0.00**	
TOTAL NATIONAL FEE =				**$860.00**	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) **(check if applicable).**			☒	**$40.00**	
TOTAL FEES ENCLOSED =				**$900.00**	
				Amount to be: refunded	$
				charged	$

☐ A check in the amount of to cover the above fees is enclosed.

☒ Charge to credit card. Credit Card Payment Form attached.

☒ The Commissioner is hereby authorized to charge any fees which may be required, or credit any overpayment to Deposit Account No. **082670** A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

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NAME

20766
REGISTRATION NUMBER

July 17, 2001
DATE

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of *

STEPHEN IVOR HALL ET AL *

New U.S. National Stage Application *
of International Application No. * Attention: DO/EO/US
PCT/GB00/00108 *

International Filing Date: *
18 January 2000 *

For: POWER SUPPLY FOR PROCESSING OF GASEOUS MEDIA

PRELIMINARY AMENDMENT

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Please amend as follows:

In the Claims:

Cancel all claims presently on file and substitute the following new claims:

17. A reactor for the processing of a gaseous medium, including a reactor bed, conduits for constraining a gaseous medium to be processed to flow through the reactor bed, a power supply unit adapted to generate and apply a potential across the reactor bed for exciting an electric discharge in the gaseous medium flowing through the reactor bed, wherein the reactor is of the dielectric barrier discharge type and the reactor bed and power supply unit are adjacent, and connected directly together electrically.

18. A reactor according to claim 17, wherein the said potential is applied across the reactor bed via electrodes in

contact with the reactor bed material and one or both sides of the electrodes are coated with a dielectric material.

19. A reactor according to claim 17, wherein the reactor bed and the power supply unit are enclosed in an electrically conducting enclosure connected to be maintained at ground potential.

20. A reactor according to claim 17, wherein the reactor bed consists of a cylindrical body of gas permeable dielectric material contained between an inner concentric gas permeable electrode and an outer concentric gas permeable electrode the outer electrode being connected to ground and the inner electrode being connected directly to the power supply unit and the gaseous medium is constrained to pass radially through he reactor bed.

21. A reactor according to claim 17, wherein the reactor bed consists of a cylindrical body of gas permeable dielectric material contained between an outer non-permeable electrode and an inner non-permeable electrode, the outer electrode being connected to ground and the inner electrode being connected directly to the power supply unit and the gaseous medium is constrained to flow axially through the reactor bed.

22. A reactor according to claim 17, wherein the reactor bed of gas permeable dielectric material is in the form of spheres, pellets, extrudates, fibers, sheets, coils, granules, wafers, meshes, frits, foams, honeycomb monolith or membrane or combinations of one or more of the above forms.

23. A reactor according to claim 17, wherein the power supply unit is adapted to produce a pulsed or alternating output voltage.

24. A reactor according to claim 17, wherein there is included means for making the resonant frequency of the electrical circuit including the reactor bed substantially equal to the frequency of the output voltage from the power supply unit.

25. A reactor according to claim 24, wherein the means for making the resonant frequency of the electrical circuit including the reactor bed substantially equal to that of output voltage from the power supply is an appropriate inductance connected in parallel with the reactor bed circuit.

26. A reactor according to claim 24, wherein the power supply unit is adapted to generate a voltage of the order of tens of kilovolts at a frequency within the range 50 Hz to 15 kHz.

27. A reactor according to claim 17 adapted to be incorporated into the exhaust system of an internal combustion engine.

28. A reactor according to claim 27, wherein there is included a step-up transformer having primary and secondary windings, an ac generator connected to the primary winding of the transformer and means for maintaining the frequency of the output from the ac generator at a pre-determined value regardless of variations in the rotational speed of the internal combustion engine in the exhaust system of which the reactor is incorporated.

29. A reactor according to claim 28, wherein the ac generator is arranged to be driven by the engine via a constant speed drive system.

30. A reactor according to claim 29, wherein the constant speed drive system consists of a hydraulic drive unit the drive efficiency of which is varied inversely with the rotational speed of the engine.

31. A reactor according to claim 29, wherein the constant speed drive system consists of a stepless variable speed transmission system the effective gear ratio of which is varied inversely with the rotational speed of the engine.

32. A reactor according to claim 29, wherein the constant speed drive system includes an electromagnetic clutch the drive efficiency of which is varied inversely with the rotational speed of the engine.

REMARKS

By this Preliminary Amendment, new Claims 17-32 are presented for examination on the merits.

Favorable action is courteously solicited.

Respectfully submitted,

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July 17, 2001

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Power Supply for Processing of Gaseous Media

The present invention relates to the processing of gaseous media and in particular to the reduction of the emission of particulate and other materials from the exhausts of internal combustion engines.

One of the major problems associated with the development and use of internal combustion engines is the noxious exhaust emissions from such engines. Two of the most deleterious materials, particularly in the case of diesel engines, are particulate carbon and oxides of nitrogen (NO_x). Increasingly severe emission control regulations are forcing internal combustion engine and vehicle manufacturers to find more efficient ways of removing these materials in particular from internal combustion engine exhaust emissions. Unfortunately, in practice, it is found that a number of techniques which improve the situation in relation to one of the above components of internal combustion engine exhaust emissions tend to worsen the situation in relation to the other. Even so, a variety of systems for trapping particulate emissions from internal combustion engine exhausts have been investigated, particularly in relation to making such particulate emission traps capable of being regenerated when they have become saturated with particulate material.

Examples of such diesel exhaust particulate filters are to be found in European Patent Application EP 0 010 384; US Patents 4,505,107; 4,485,622; 4,427,418; and 4,276,066; EP 0 244 061; EP 0 112 634 and EP 0 132 166.

In all the above cases, the particulate matter is removed from the exhaust gases by a simple, physical

trapping of particulate matter in the interstices of a porous, usually ceramic, filter body, which is then regenerated by heating the filter body to a temperature at which the trapped diesel exhaust particulates are burnt off. In most cases the filter body is monolithic, although EP 0 010 384 does mention the use of ceramic beads, wire meshes or metal screens as well. US Patent 4,427,418 discloses the use of ceramic coated wire or ceramic fibres.

In a broader context, the precipitation of charged particulate matter by electrostatic forces also is known. However, in this case, precipitation usually takes place upon large planar electrodes or metal screens.

It is known also to remove pollutants from internal combustion engine exhaust gases by establishing an electric discharge in a reactor chamber through which the exhaust gases are made to pass. The electric discharge causes the conversion of the pollutants to less harmful materials, which are discharged from the reactor chamber to the atmosphere. Examples of such devices are given in GB 2 274 412; European Patent Application 0 366 876; OLS DE 3708508; and US Patent 3,180,083.

However, in the above mentioned systems the high voltages required to excite the electric discharges are generated by power sources which are remote from the devices in which the removal of the pollutants from the exhaust gases is carried out. Not only does this require the use of high voltage transmission systems with their attendant safety implications, but in cases where pulsed dc or ac voltages are used to excite the electric discharges, considerable electromagnetic emissions can occur.

It is an object of the present invention to provide a reactor device especially suitable for the reduction of internal combustion exhaust emissions in which these problems are addressed.

Our published patent application WO99/05400 describes and claims a reactor for the processing of a gaseous medium, including a reactor bed, means for constraining a gaseous medium to be processed to flow through the reactor bed and a power supply unit adapted to generate and apply a potential across the reactor bed which is sufficient to excite an electric discharge in the gaseous medium flowing through the reactor bed, wherein the reactor bed and the power supply unit are adjacent, directly connected together electrically, preferably co-axial, and preferably are enclosed in an electrically conducting enclosure which is adapted to be maintained at ground potential.

We have now found that a particularly advantageous form of reactor for use in combination as aforesaid with an adjacent, directly coupled power supply is a reactor of the dielectric barrier discharge type also known as a silent discharge reactor.

Accordingly, the present invention provides a reactor for the processing of a gaseous medium, including a reactor bed, means for constraining a gaseous medium to be processed to flow through the reactor bed and a power supply unit adapted to generate and apply a potential across the reactor bed which is sufficient to excite an electric discharge in the gaseous medium flowing through the reactor bed, wherein the reactor is of the barrier discharge type and wherein the reactor bed and the power supply unit are adjacent, directly connected together electrically, preferably co-axial, and preferably are

enclosed in an electrically conducting enclosure which is adapted to be maintained at ground potential.

Not only does the grounded enclosure isolate electrically the reactor bed and the power supply unit but it acts as a Faraday cage so as to prevent the emission of electromagnetic radiation when pulsed dc or ac potentials are used to excite the gaseous medium.

Preferably, the enclosure consists of a sealed metal chamber enclosing the reactor bed and the power supply unit. Alternatively the enclosure can be non-metallic or partially metallic but surrounded by a metallic coating or other metal structure.

Preferably the reactor bed consists of a cylindrical body of gas permeable dielectric material contained between two concentric gas permeable electrodes the outer one of which is grounded and the inner one of which is connected directly to the means for generating the said potential, one or both sides of the electrodes in contact with the reactor bed material being coated with a dielectric material that constitutes the dielectric barrier. Dielectric material in the bed and on the electrodes need not necessarily be the same material. In use the potential applied excites a non-thermal plasma discharge in the region between the electrodes.

Preferably the reactor bed comprises a body of gas permeable dielectric material in the form of spheres, pellets, extrudates, fibres, sheets, coils, granules, wafers, meshes, frits, foams, honeycomb monolith or membrane in the plasma region of the non-thermal plasma. Combinations of one or more of the above forms of gas permeable dielectric bed material can be used and can be arranged to create a structure with a non-uniform surface

area and porosity, for example a graded porosity, when presented to the gas.

In a particular embodiment of the invention the reactor chamber is adapted to form part of the exhaust system of an internal combustion engine.

The invention will now be described, by way of example, with reference to the accompanying drawings in which,

Figure 1 is a longitudinal section of a reactor for reducing exhaust emissions from an internal combustion engine;

Figure 2 is a representation of the electrical circuits associated with the present invention.

In Figure 1 a particular embodiment of reactor design is shown wherein both electrodes have a dielectric barrier coating. But the design is equally applicable when only one of the electrodes has such a coating. Referring to Figure 1 of the drawings a reactor assembly 1 for treating the exhaust gases from internal combustion engines comprises a reactor bed 2 which consists of a bed 3 of pellets 4 of a ceramic dielectric material, such as described in our earlier patent GB 2 274 412, which is contained between inner and outer perforated stainless steel electrodes 5 and 6 respectively. Surfaces of the electrodes are coated with an insulating layer of dielectric, represented schematically at 7 and 8. The thickness of this coating depends upon the breakdown strength of the dielectric material used, but will typically be of the order of 1mm or 2mm. The coating extends in this example to cover the inner surfaces of the perforations in the steel electrodes but such as to

allow passage of exhaust gas through the perforations in the radial direction shown. This is illustrated in the enlarged inset in Figure 1 in which the perforations are referenced 25.

The inner electrode 5 is closed by a stainless steel thimble 9 which is connected directly to a high voltage power supply 10, which is capable of delivering 30 kV pulses at a repetition frequency in the range 50 Hz - 15 kHz. The ends of the reactor bed 2 are closed by two ceramic end-plates 11 and 12 respectively which also act as support plates. The end-plate 11, which is at the same end of the reactor bed 2 as the thimble 9 has a series of axial holes 13 around its periphery. Also at the ends of the electrodes 5 and 6 are stainless steel rings 14, 15, and 16 which are so shaped as to reduce as far as is practicable arcing between the ends of the electrodes 5 and 6 and their respective end-plates 11 and 12. The whole assembly is encased in a gas tight stainless steel chamber 17. Thermal expansion of the reactor bed 2 is accommodated by expansion rings 18 positioned between the supports 11 and 12 and respective abutments 19 and 20, which form part of the chamber 17. The power supply 10 is positioned within the chamber 17 by perforated plates or spiders 21. The chamber 17 has inlet and outlet nozzles 22 and 23, respectively, by means of which it can be attached to the remainder of an internal combustion engine exhaust system, which is not shown in the drawing.

The power supply 10, which is positioned at the cooler end of the reactor assembly 1, includes an inverter for converting a dc input 24 from a vehicles power supply to a pulsed, or alternating form and transforming it to some 30 kV before applying it to the inner electrode 5 of the reactor bed 2. The voltage shape

can take the form of a regularly varying wave such as sinusoidal ac, which may be half-wave rectified, the form of a unipolar or bipolar square wave or a unipolar or bipolar pulse. Of course it is necessary to ensure that the components of the power supply 10 are capable of operating at the relatively high temperatures which exist in internal combustion engine exhaust systems. The direction of gas flow shown helps to reduce the temperature of the exhaust gases before they reach the power supply 10. However, if the power supply 10 is capable of withstanding the higher temperatures it can be positioned at the other end of the reactor assembly 1.

Referring to Figure 2, the electrical components of a gas discharge reactor such as those described above can be represented primarily as a resistive load R_L of the order of hundreds of kilo ohms and a capacitive load C_L of the order of hundreds of pico farads in parallel with the resistive load of R_L. The reactor 201 is shown as being connected to a power supply 202 which includes a pulsed DC source or AC generator 203, a power amplifier 204 and a step-up transformer 205. The power supply 202 produces an output potential of some 20 kV at a frequency of about 10 kHz. At this sort of frequency, the capacitive current through the reactor 201 may be a factor of ten greater than the resistive current. It is the resistive component of the current flowing through the reactor 201 which is the effective one so far as the operation of the reactor 201 is concerned. In order to minimise the size of the capacitive current drawn from the power supply 202, and hence the size of the power supply 202, a variable inductance 206 is connected in parallel with the reactor 201 and its value is adjusted until the LCR circuit formed by it and the resistive and capacitive components R_L and C_L of the reactor 201 is

resonant at the output frequency of the power supply 202. A typical value for the inductance is some 3 henries. At least some of this can be supplied by the secondary winding 207 of the output transformer 205 in the power supply 202. When the LCR circuit is resonant with the output from the power supply 202, the reactive current drawn from the power supply 202 is small, leaving only the resistive component, which therefore can be much greater for a given power supply than otherwise would be the case.

Where the tuning inductance is formed by the secondary winding of the transformer 205 alone. The reactive current will flow through the secondary winding 207 of the transformer 205. At resonance, however, the reactive current will not be seen in the primary winding of the transformer 205, so that the power demanded from the power source 203 will be minimised.

In the case of a reactor for the treatment of vehicle exhaust gases, the AC generator 203 may be driven by the engine of a vehicle in the exhaust system of which the reactor 201 is incorporated. However, a problem which then arises is that the frequency of the output current from the generator 203 is dependent upon the engine speed, which is undesirable, particularly when it is desired to operate the reactor 201 at the resonant frequency of the combined transformer secondary winding 204 and reactor 202 circuit, as above.

One way of overcoming this problem is to incorporate a constant speed drive unit between the engine of the vehicle and the generator 203.

A first form of constant speed drive unit which can be used consists of a variable displacement pump driven

by the engine of the vehicle which is connected via a pressure or flow regulating system to an hydraulic motor so as to deliver a constant speed output drive to the generator 203 whatever the engine speed.

A second form of constant speed drive can be provided by including a fluid viscous coupling between the engine and the generator 203. Such couplings consist of a turbine the casing of which is driven by one component of the system and the impellor of which drives the other component of the system. The drive speed is controlled either by varying the amount of fluid in the coupling or by varying the angle of the impeller blades.

A hydro-mechanical constant drive system which can be used consists of a number of driver and driven metal disks, the depth of immersion of which in a bath of a viscous oil can be varied in response to engine speed signals generated by a transducer. As the depth of immersion of the disks is increased, so the slippage between them is reduced, and vice versa.

A purely mechanical adjustable speed system consists of two spring-loaded axially adjustable v-pulleys and belts. The engine is coupled to one pulley and the generator 203 to the other. The diameter of the pulley coupled to the engine is varied inversely with the engine speed.

A somewhat similar system employs two conical disks between which there are two planetary cones. Rotation by the engine of the disk coupled to it causes the cones to rotate both the main axis of the drive system and about their own axes. The closer these two rotational speeds are, the slower is the rotation of the other disk connected to the generator 203. Maintenance of the

output drive speed is achieved by means of a control ring which alters the rotation of the planetary cones about their own axes.

An electrical controlled speed drive system includes a dc electric motor operated by the vehicle's battery which powers an hydraulic motor which is coupled to the generator 203.

A further controlled speed drive system utilises a variable magnetic field generated across an air gap between two ferromagentic disks, one coupled to the engine and the other to the generator 203.

The invention is not restricted to the details of the foregoing examples. For instance, whilst a radial flow configuration is preferred an axial flow configuration is possible. In that case, the electrodes are constructed to be impermeable to the exhaust gases and the end supports are appropriately perforated to allow axial flow therethrough.

Claims

1. A reactor for the processing of a gaseous medium, including a reactor bed (2), means (17,22,23) for constraining a gaseous medium to be processed to flow through the reactor bed (2), a power supply unit (10) adapted to generate and apply a potential across the reactor bed (2) which is sufficient to excite an electric discharge in the gaseous medium flowing through the reactor bed (2), characterised in that the reactor is of the barrier discharge type and in that the reactor bed(2) and power supply unit (10) are adjacent, and connected directly together electrically.

2. A reactor according to claim 1, further characterised in that the said potential is applied across the reactor bed (2) via electrodes in contact with the reactor bed material (4) and one or both sides of the electrodes (5;6) are coated with a dielectric material (7;8).

3. A reactor according to claim 1 or claim 2, further characterised in that the reactor bed (2) and the power supply unit (10) are enclosed in an electrically conducting enclosure (17) adapted to be maintained at ground potential.

4. A reactor according to any of claims 1,2 or 3, further characterised in that the reactor bed (2) consists of a cylindrical body (3) of gas permeable dielectric material (4) contained between two concentric gas permeable electrodes (5;6) the outer one (6) being connected to ground and the inner one (5) being connected directly to the power supply unit (10) and the gaseous medium is constrained to pass radially through the reactor bed (2).

5. A reactor according to claim 1 or claim 2, further characterised in that the reactor bed (2) consists of a cylindrical body of gas permeable dielectric material contained between two non-permeable electrodes, the outer one being connected to ground and the inner one is connected directly to the power supply unit (10) and the gaseous medium is constrained to flow axially through the reactor bed (2).

6. A reactor according to any preceding claim, further characterised in that the reactor bed (2) of gas permeable dielectric material (4) is in the form of spheres, pellets, extrudates, fibres, sheets, coils, granules, wafers, meshes, frits, foams, honeycomb monolith or membrane or combinations of one or more of the above forms.

7. A reactor according to any preceding claim, further characterised in that the power supply unit (10) is adapted to produce a pulsed or alternating output voltage.

8. A reactor according to any preceding claim, further characterised in that there is included means (206) for making the resonant frequency of the electrical circuit including the reactor bed (2) substantially equal to the frequency of the output voltage from the power supply unit (10).

9. A reactor according to claim 8, further characterised in that the means (206) for making the resonant frequency of the electrical circuit including the reactor bed (2) substantially equal to that of output voltage from the power supply (10) is an appropriate inductance connected in parallel with the reactor bed circuit.

10. A reactor according to Claim 8 or Claim 9, further characterised in that the power supply unit (10) is adapted to generate a voltage of the order of tens of kilovolts at a frequency within the range 50 Hz to 15 kHz.

11. A reactor according to any preceding claim adapted to be incorporated into the exhaust system of an internal combustion engine.

12. A reactor according to claim 11, further characterised in that there is included a step-up transformer (205), an ac generator (203) connected to the primary winding of the transformer and means for maintaining the frequency of the output from the ac generator (203) at a pre-determined value regardless of variations in the rotational speed of the internal combustion engine in the exhaust system of which the reactor is incorporated.

13. A reactor according to Claim 12, further characterised in that the ac generator (203) is arranged to be driven by the engine via a constant speed drive system.

14. A reactor according to Claim 13, further characterised in that the constant speed drive system consists of an hydraulic drive unit the drive efficiency of which is varied inversely with the rotational speed of the engine.

15. A reactor according to Claim 13, further characterised in that the constant speed drive system consists of a stepless variable speed transmission system the effective gear ratio of which is varied inversely with the rotational speed of the engine.

16. A reactor according to Claim 13, further characterised in that the constant speed drive system includes an electromagnetic clutch the drive efficiency of which is varied inversely with the rotational speed of the engine.

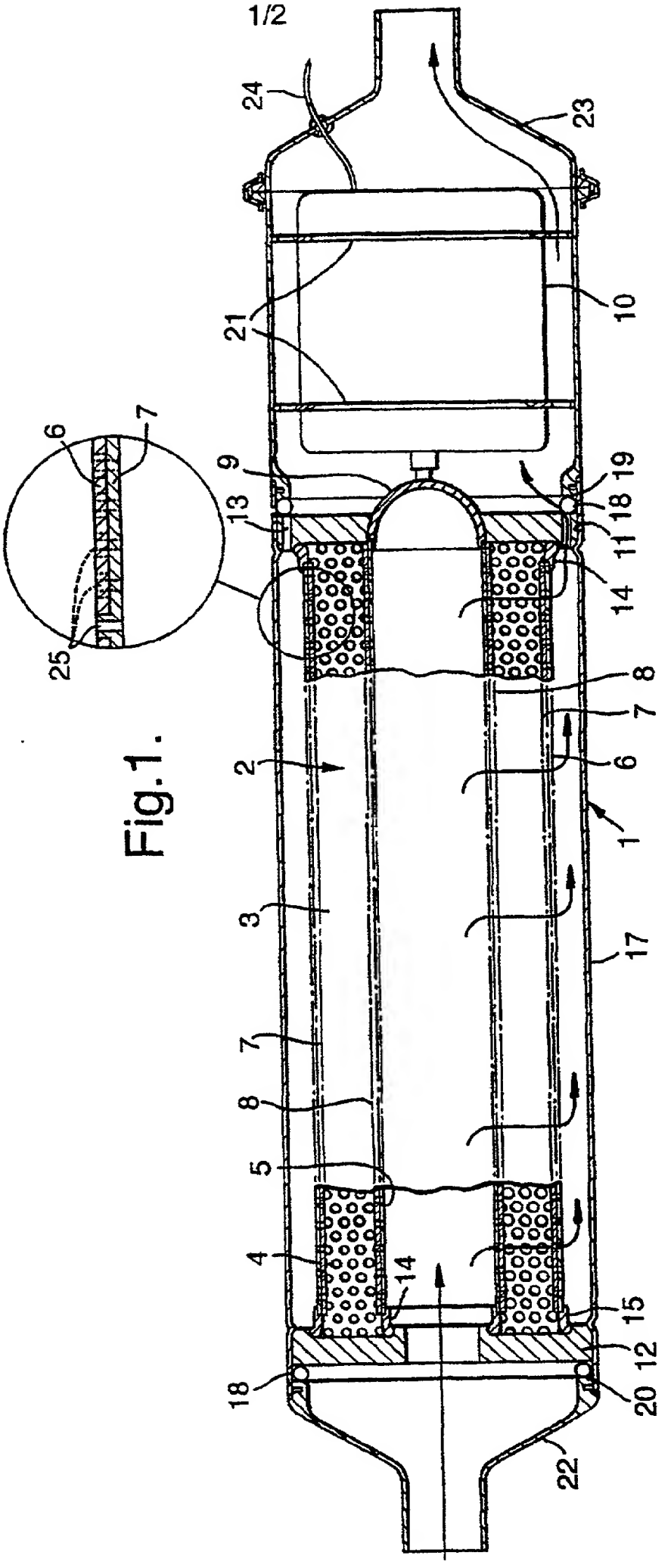

Fig.1.

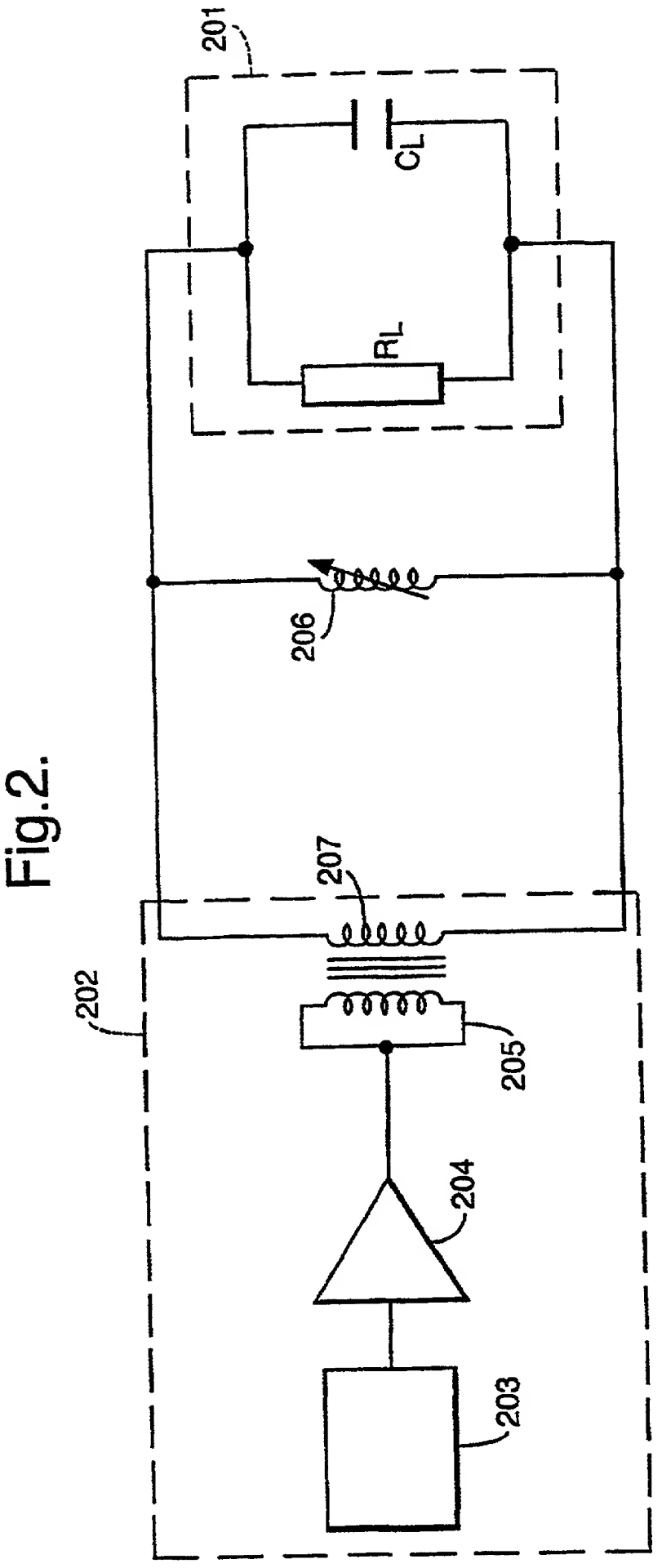

Fig.2.

COMBINED DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION (USA)

(INCLUDING DESIGN PATENT APPLICATIONS)

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled Power supply for processing of gaseous media

the specification of which is attached hereto, unless the following box is checked:

[ ] was filed on 18th January 2000 ✓ as United States Application Number or PCT International Application No. PCT/GB00/00108 ✓ and was amended on 13th September 2000 (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

(Number)	(Country)	(Day/Month/Year Filed)	Priority Claimed [X] Yes	Priority Claimed [ ] No
99 01219.7 ✓	United Kingdom	21st January 1999 ✓		
			Priority Claimed [ ] Yes	Priority Claimed [ ] No

[ ] Additional applications identified on attached sheet.

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

(Application Serial Number)	(Filing Date)	(Status) (patented, pending, abandoned)

[ ] Additional applications identified on attached sheet.

I hereby appoint the following attorneys to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith:

William H. Holt, Reg. No. 20766; D. Peter Hochberg, Reg. No. 24603; Ronald E. Greigg, Reg. No. 31517; Howard M. Ellis, Reg. No. 25856

Direct all telephone calls to WILLIAM H. HOLT, Telephone Number: (703) 838-2700

Address all correspondence to LAW OFFICES OF WILLIAM H. HOLT, 1423 Powhatan Street, Unit 2, First Floor, Alexandria, Virginia 22314.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full name of Sole or First Inventor	Inventor's Signature	Date
Stephen Ivor HALL	Stephen Ivor Hall	2nd July 2001
Residence Oxford, Oxfordshire, United Kingdom GBX		**Citizenship** British
Post Office Address c/o Accentus plc, Patents Dept, 329 Harwell, Didcot, Oxfordshire, OX11 0QJ, United Kingdom		
Full name of Second Joint Inventor Michael INMAN	**Inventor's Signature** Michael Inman	**Date** JUNE/29/2001
Residence Abingdon, Oxfordshire, United Kingdom GBX		**Citizenship** British
Post Office Address c/o Accentus plc, Patents Dept, 329 Harwell, Didcot, Oxfordshire, OX11 0QJ, United Kingdom		
Full name of Third Joint Inventor Anthony Robert MARTIN	**Inventor's Signature** Anthony Robert Martin	**Date** 29 June 2001
Residence Abingdon, Oxfordshire, United Kingdom GBX		**Citizenship** British
Post Office Address c/o Accentus plc, Patents Dept, 329 Harwell, Didcot, Oxfordshire, OX11 0QJ, United Kingdom		

[ ] See attached sheet for similar information and signatures for additional joint inventors.

COMBINED DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION (USA)

(INCLUDING DESIGN PATENT APPLICATIONS)

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled Power supply for processing of gaseous media

the specification of which is attached hereto, unless the following box is checked:

[ ] was filed on 18th January 2000 as United States Application Number or PCT International Application No. PCT/GB00/00108 and was amended on 13th September 2000 (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

(Number)	(Country)	(Day/Month/Year Filed)	Priority Claimed
99 01219.7	United Kingdom	21st January 1999	[X] Yes [ ] No
			[ ] Yes [ ] No

[ ] Additional applications identified on attached sheet.

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

(Application Serial Number)	(Filing Date)	(Status) (patented, pending, abandoned)

[ ] Additional applications identified on attached sheet.

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Full name of ~~Sole or First Inventor~~ 4th joint inventor David RAYBONE	Inventor's Signature DJR	Date 29th June 2001
Residence Gloucester, Gloucestershire, United Kingdom GBX		Citizenship British
Post Office Address c/o Accentus plc, Patents Dept, 329 Harwell, Didcot, Oxfordshire, OX11 0QJ, United Kingdom		
Full name of ~~Second Joint Inventor~~ 5th joint inventor David Michael WEEKS	Inventor's Signature David Michael Weeks	Date 29 June 2001
Residence Abingdon, Oxfordshire, United Kingdom GBX		Citizenship British
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Full name of ~~Third Joint Inventor~~ 6th joint inventor David Leslie SEGAL	Inventor's Signature David Leslie Segal	Date 29 June 2001
Residence Abingdon, Oxfordshire, United Kingdom GBX		Citizenship British
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[ ] See attached sheet for similar information and signatures for additional joint inventors.